Novel Anisotropic Dynamic Flame Thickening Approach for Technically Premixed Flames

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Accurately predicting the premixed flame structure through analytical modelling in the case of fuels with a strong preferential diffusion remains a challenge in the field of numerical combustion. A very attractive route is to thicken the flame front by means of artificial thickening through the Dynamic Thickened Flame Model approach [1]. This model formulation has been widely used for modelling perfectly premixed and technically premixed flames along the last decades. However, in technically premixed scenarios the alteration of the diffusivity inside the flame front can lead unphysical reactants mixing acceleration. Accordingly, the effect of the conventional homogenous isotropic thickening is to induce a sensible decrease in the local level of unmixedness inside the flame front.

In this study, a new formulation of the Dynamic Thickened Flame Model (DTFM) is proposed by introducing an anisotropic diffusivity alteration in which the species and energy diffusivity are enhanced exclusively in the direction normal to the flame front. Unlike classical isotropic thickening, which uniformly alters flame structures, the anisotropic approach preserves tangential gradients limiting the enhancement of the mixing inside the thickened flame front.

The new modelling is implemented in the Open-source software OpenFOAM and tested on a laminar test case to better investigate the impact of an anisotropic thickening. A motion driven predominantly by diffusion effects is therefore looked for to better appreciate the contribution of the model. A comparison between the anisotropic and isotropic formulations is presented, highlighting the improvements achieved with the novel approach.

References

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